ORCHARD AND VINEYARD LAND USE, PROBLEMS AND CONSERVATION TREATMENT

WESTERN STATES

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WESTERN STATES

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Introduction

Commercial fruit production in the Western States dates from near the last decade of the nineteenth century. Completion of transcontinental railroads made possible fresh fruit shipments to midwestern and eastern markets. The long growing season found in most western fruit growing States is characterized by a high percentage of possible sunshine with relatively rainless summers. With water supplied by irrigation, these conditions are favorable for the production of fruit of high color and excellent quality. Markets are distant and shipping costs relatively high. Western fruit growers early recognized that only high quality, carefully graded, securely packed, attractive fruit would sell on eastern markets at a premium in competition with locally grown fruit. The quality and market appeal of western fruits have continued to improve through this century to the present.

Land Use Aspects of Fruit Production

Orchard and vineyard land use differs from that of the more common farm crops in one important aspect. These crops are long-lived perennials. Once these enterprises are established, the land is committed to a single perennial crop for periods that may extend through several decades to a half century or longer. Climatological, topographical, soil textural and profile characteristics and other site and soil features are fixed for the life expectancy of the enterprise.

Farm crops, in contrast, may be rotated each year from one farm field to another. Shallow rooted crops may alternate with those of deeper rooting habit on the same field. Specific crops may thus be grown on fields which have been especially preconditioned annually or every few years to provide improved soil conditions for crops which follow.

The selection of sites for orchards and vineyards and the preparation of these sites for such a long period of use is a most critical determination. Subsequent modification of adverse soil and site characteristics or the application of alleviatory measures is, at best, severely limited. Under these conditions, the wise management of soil and water resources becomes increasingly important.

1/ Formerly Washington-Field Soil Conservationist, Farm and Ranch Planning Division, Berkeley, Calif. June 1962

Climate and Western Fruit Areas

A wide range of climatic conditions in the western States permits the production of all fruit crops adapted to the temperate and subtropical climatic zones. Important tree fruit industries of apples, pears, cherries, peaches, prunes, plums, apricots, and other temperate climatic fruits are found in the irrigated valleys of central Washington, central and southern Oregon, southwest Idaho, the Great Basin of Utah and in California.

The western citrus industry centers in the subtropical southern coastal area, the southern San Joaquin and Coachella Valleys of California and in the Salt River Valley and on the Yuma Mesa of Arizona. Western avocado production is limited to southern coastal California, while dates are grown commercially only in the hot desert valleys of the Lower Colorado River Basin of California and Arizona.

Of other subtropical fruits, the fig, Persian walnut, Japanese persimmon, pomegranate and the Vinifera grape are produced in the less frost-free subtropical climatic zone of California and Arizona. The vast Vinifera table and wine grape industry of the United States centers in the great central valleys of California and extends into southern California coastal and interior valleys. The production of early Vinifera table grapes is an expanding industry of southern Arizona, while the eastern or labrusca type grapes are best adapted to the temperate climatic zone and are grown in parts of Washington, Idaho, Utah, Oregon and California.

A range in climatic conditions, provides varying lengths of growing season and wide differences in total available heat units which influence the time of maturity and extends the market period of most fruits. The marketing season is further extended by growing early, midseason and late maturing varieties.

The Importance of Micro-climate.

An excellent treatment of this subject with special reference to the water factor in soil-plant-atmosphere relationships has been published by UNESCO 1/ as a part of it's Arid Zone program.

Many fruit plants have rather specific climatic requirements or limitations at certain stages of tree growth or during the blossoming, fruit setting and fruit development period. These involve the micro-climate at and near ground level in the orchard and vineyard. Of principal interest are the complex

1/ PRACTICAL CLIMATOLOGY: R. O. Slatyer and I. C. Mcllroy; UNESCO, 1961

inter-relationships between plants and the immediate environment to which they are exposed. The principal elements of micro-climatology of concern to fruit growers are atmospheric temperature, relative humidity and air movement. It is important to understand the factors which influence these and the extent within practical limits of management that adverse extremes can be modified or alleviated.

Temperature. Heat reaches the earth's surface as short-wave solar radiation. About half of this is depleted before it reaches the earth's surface. In arid regions, with a minimum of interference from clouds and atmospheric water vapor, this proportion may be as much as 70%. At the ground surface, a part of this already depleted radiation is reflected back into the atmosphere and the residue is absorbed. That which is reflected warms the air near the ground while that portion absorbed increases the temperature of the soil and of objects on the soil surface. It is this portion that is of most importance in micro-climate. Its effectiveness is influenced by both atmospheric and ground surface conditions.

There is also a significant emittance of long-wave radiant heat from the ground surface to the atmosphere. This is of especial importance during night time. These fractions of solar radiation affect the vertical atmospheric profiles of temperature and humidity near the ground surface and are of direct interest to the fruit grower.

At night, a net radiation loss from the soil to the atmosphere takes place progressively from sunset to after sunrise the following morning. Colder, heavier air layers develop near the ground surface overlain with warmer, lighter air. This nocturnal temperature inversion is characteristic of orchard conditions on quiet nights when frost may occur. On sloping orchard sites, the colder, heavier air layer near ground level moves gravitationally down slope away from a particular orchard area. This phenomenon is spoken of by orchardists as "air drainage." The colder air about the fruit plants is replaced by somewhat warmer air to afford several degrees of frost protection.

Soil Surface Conditions influence the amount of solar radiation that will be absorbed. A bare, firm, dark colored soil surface will absorb a maximum of available heat. At the other extreme is a light-colored mulch with a low coefficient of thermal conductivity which insulates the soil against heat absorption. A growing covercrop affects heat absorption and emission somewhere between that of the bare ground and a mulch surface.

While a soil with a vegetative cover will warm less in daytime than will a bare soil, the temperature of a soil with a vegetative cover will generally be slightly higher at night. A vegetative cover reduces diurnal temperature fluctuation of the soil surface.

A freshly cultivated soil has reduced bulk density and increased entrapped air causing a marked reduction of thermal diffusibility over that of a firm, bare soil. Thus, any temperature advantage in a fruit planting with a bare soil may be reduced by cultivation to near that of a soil with covercrop.

Atmospheric humidity is generally higher over a dense vegetative cover than over a bare soil. This is due to high evapotranspiration from the plant cover and is closely related to atmospheric temperature. Covercrops in fruit plantings can effect a significantly more favorable micro-climatic environment for newly-set and developing fruits, especially in periods of excessively high temperature.

Small fruits of the Washington Navel orange which set parthenocarpically without the stimulus of blossom fertilization and seed development are particularly sensitive to excessive transpirational stress. An abscission layer of cells is induced across the fruit stem which cuts off further sap supply to the small fruits. The excessive shedding of these fruits is commonly know as "June drop" and is especially severe in the hot desert citrus areas of California and Arizona.

The June 1961 high temperature period was reported to have reduced the Tulare County, California, Washington Navel crop by 2,000 cars by excessive "June drop" of the small fruit.

Wind is an important element in the micro-climate of fruit growing areas. A persistent "canyon" breeze will commonly prevail on frosty nights in narrow valleys and along the upper reaches of broader valleys where they emerge from mountain canyons. Even a gentle but persistent wind will mix the inversion air layers and prevent damaging ground temperatures. While mild air movement will generally reduce or eliminate the likehood of frost occurrence, low temperatures from winds of massive cold fronts are difficult to contend with. Temperature inversion air layers are non-existent under these conditions.

Persistant prevailing winds cause fruit scarring and may cause considerable fruit drop. Windbreaks are used in many areas to reduce fruit loss and depreciated grade at harvest time.

Frost protection. Young fruit plants are more tender to cold damage than are more mature ones. The trunks of young citrus trees are wrapped in the fall with paper, cardboard or a small bundle of corn or sorghum stalks and hilled with soil above the bud union for winter protection. The development of succulent vegetative growth into the fall period is avoided to provide more mature, cold resistant tissue.

A number of alleviatory temperature modification measures are practiced by fruit growers to protect citrus fruit crops on the trees during the midwinter period and the tender blossoms of deciduous fruits in spring from frost damage. "Smudging" was practiced by early orchardists in the west. The dense smoke produced was thought to simulate a cloud cover and reduce the severity of frost. Old automobile tires now used by some orchardists produces both smoke and intense heat. Heat is considered the more effective agent with this practice.

Essentially smokeless orchard heaters are extensively used for frost protection. This method takes advantage of temperature inversion of the air about and above the fruit plants. Heat from fuel combustion rises from the heaters to a height where the rapidly cooled air reaches a layer of equal temperature where it comes to rest. Additional heated air will attain its temperature "ceiling" at progressively lower levels until the fruit plants are enveloped in a warmer air layer.

Wind machines are now used in hundreds of citrus orchards in California and Arizona to provide frost protection to fruit on the trees during the midwinter period. These operate to mix the colder, heavier air at tree level with the warmer "inversion" air at from 50 to a few hundred feet above the orchard area. As much as five degrees temperature rise is possible with this method. One machine is commonly used for each ten acres of orchard.

Irrigation water spread over the soil surface at night or released from sprinklers is used by fruit growers for frost protection. Latent heat is released from the water to the colder air. As air temperatures reach the freezing point of water, heat energy release through ice crystal formation becomes available to favorably modify the air temperature about the fruit plants.

Site Considerations

A prospective orchardist will normally undertake a fruit growing enterprise in an area with a history of successful production of the fruits to be grown. Otherwise, a study of meteorological records and of soil survey maps of the area will reveal the pattern of the climatic complex and the important soil characteristics. In many instances, favorable micro-climatic factors are placed in higher priority than are soil conditions in selecting sites for fruit growing enterprises.

Soils. Orchard and vineyard plants are deep-rooted as a class. A more ideal soil for most fruit plants is deep, of medium to light texture with unimpaired internal drainage. Permeability should be in the range of moderate to moderately rapid. Soils with profile characteristics which severely limit the intake and movement of water and air and which restrict or inhibit root development in the surface five feet of soil, are generally unfavorable for the successful production of these crops. Yet, many thousands of acres of

orchards and vineyards are established on soils with severe textural, slope or profile limitations. Soils of strongly sloping valley periphery sites and those on benches, terraces and foothills are commonly coarser, more shallow and less developed.

Site preparation for orchard and vineyard enterprises should be based on detailed soil survey information and fitted to a carefully designed irrigation system. This can involve expensive land grading and smoothing. A surface irrigation system may not be practical on strongly sloping sites with coarse texture or shallow soil. Blasting tree holes or deep ripping into or through a cemented substratum for establishing orchard trees can seldom improve a soil sufficiently to justify the high investment associated with orchard enterprises. Many orchard developments on unfavorable sites are speculative in character to be passed on in small units to individual investors. With good management, these can develop satisfactorily to maturity. All too frequently, they can have but a limited period of sustained high productivity before tree condition and production decline to an uneconomic level. Some areas have resorted to drainage projects to remove excess water from a perched water table in the root zone of shallow, poorly drained soils.

Conservation Treatment and Management Measures

With so many orchard enterprises established on less favorable soils and sites, soil and irrigation water management practices must be carefully planned and meticulously followed if successful enterprises are developed and maintained. On the most favorable sites, the wise management of soil and water will return high dividends in fruit yields and economic operations.

Irrigation.

Soil erosion is a common hazard in many typical orchard and vineyard areas of the West. Selection of the irrigation system and its design must be fitted to slope and soil conditions to reduce or eliminate soil losses and to permit efficient water use. The objective of an irrigation is to replenish soil moisture in the root zone which has been partially depleted by plant use.

Surface irrigation is the method most extensively used for orchards and vineyards. The use of broad, shallow furrows directly down short, moderate slopes can adequately distribute the irrigation water over the orchard area. Connecting, cross-slope furrows between trees in the rows may be added to slow the irrigation stream for more adequate penetration into finer textured soils.

The orchard site may be prepared with contour bench terraces across the dominant slope with the use of an appropriate irrigation furrow gradient on the terraces. Some moderately sloping sites may be irrigated with a more satisfactory furrow gradient diagonal to the tree rows, or with the tree rows oriented in the direction of an acceptable irrigation slope. Nearly level or level valley, terrace or mesa orchard sites are commonly flood irrigated between borders of slight gradient or in practically level basins.

In all cases, the length of the irrigation run should be fitted to the soil and slope conditions to permit water distribution within a reasonable time over all portions of the orchard area, with a minimum of soil movement by the irrigation stream. Excessive water loss in tail-water flow or by penetration below the root zone is to be avoided. Adjustment of the size of furrow stream and of the duration of the application are subject to control by the irrigator to attain irrigation water penetration to root zone depths requiring soil moisture replenishment.

Sprinkler irrigation systems were first used in orchards some 40 years ago. Citrus fruit growers were the first to extensively use this method of irrigation. Orchardists changed to the sprinkler system or installed them to overcome or avoid some of the shortcomings and inadequacies of surface irrigation on complex orchard sites. Steeper slopes and coarse textured soils that could not have been irrigated by a surface method became feasible of orchard development with sprinkler irrigation. A permanent covercrop needed on such sites for erosion control is difficult to establish and maintain except with a sprinkler system. Little land grading is required before establishing an orchard to be irrigated with a sprinkler system. In many cases, the cost of a sprinkler system is less or no more than concrete ditches or pipelines and land terracing or heavy grading required for reasonably adequate surface irrigation.

Proper irrigation water management involves the timing, distribution, control and duration of an irrigation application. Adequate control and distribution of the irrigation water over the orchard area are facilitated by a well designed and installed irrigation system fitted to the soil textural, profile, and slope conditions. Timing of the irrigation for interval and duration of the application is subject to the discretion and judgement of the operator.

The rate of soil moisture use by plants and consequently, the need for replenishment will vary widely at different seasons of the year, with covercrop use and with different age and size of trees or vines. Rate of use is related rather directly to atmospheric conditions of temperature, humidity and air movement. With deciduous fruit plants, soil moisture use is obviously limited to the growing season when the plants are carrying actively transpiring foliage. The rate of soil moisture use by citrus trees in desert areas, may be six times as great in July as in January.

An intelligent orchardist and vineyardist will examine the soil at different root zone depths for soil moisture conditions at intervals throughout most of the year, and especially during critical periods of the growing season. He will learn the soil depth of greatest root activity and soil moisture depletion. He will generally time an irrigation application when this area indicates a depletion of near 60% of the available soil moisture.

No benefit can result by applying water to a soil that is already wet and serious harm to fruit plants can result where this is a recurring practice. A principal adverse effect is impaired aeration in the root zone. Most fruit plants are sensitive to the soil oxygen supply. Citrus fruit plants are especially so, with the pear one of the least sensitive. Air can be drawn into the soil root zone only as soil moisture is withdrawn, first by drainage of free water from the pore spaces following an irrigation. These spaces then enlarge as the plant roots continue to absorb water from the moisture film about each soil particle.

Research has shown 1/ that a soil with an oxygen diffusion rate in the order of 40 or more will maintain a soil oxygen supply sufficient to support optimum plant growth. If the diffusion rate is less than 20 on the scale used, roots will not grow in that soil area. Roots not actively elongating, cannot produce and maintain functioning root hairs. Without these, absorption of water and plant nutrients is severely restricted.

The timing of an irrigation application becomes increasingly critical on soils with poor internal drainage. The soil root zone is saturated to the depth of water penetration with each irrigation. Where an impervious substratum or one of slow permeability is present in the root zone, gravitational movement of surplus water from the root zone is prevented or restricted. If subsequent irrigations are applied before a substantial amount of the soil moisture is withdrawn by the plants from the restricted root zone, a perched water table is created and maintained. Root health and functioning is impaired due to reduced aeration. Fruit plants cannot continue to thrive and produce satisfactory crops under these conditions.

Different methods are used by fruit growers to determine the timing and adequacy of irrigations. Where soil conditions and tree development vary widely, several locations should be examined. A shovel or soil auger is most commonly used to appraise the relative soil moisture content at different soil depths. Soil moisture instruments called tensiometers are being used in increasing degree by orchardists. These may be installed at one to several locations in a planting. One may be set at the most critical soil depth i.e., 18 inches or 24 inches, or two or three may be used at a given location, each set at a different depth in the root zone.

1/ Soil aeration-Essential for maximum plant growth - Citrus Experiment Station, UCR. California Agriculture, March, 1962

Since tensiometers record the degree of soil moisture depletion directly on a dial, no calibration is necessary. When the instrument at a soil depth of greatest root concentration reaches a predetermined reading, it is time to irrigate. The duration of a given irrigation is judged by the reading of this instrument or of one placed at a lower depth. When water penetrates the soil to the instrument depth, soil moisture tension is virtually eliminated and the reading approaches zero.

> "Strong support based on much field experience is now available for the conclusion that irrigation regimes for economic yields of most crops can be specified most simply in terms of tensiometer readings." 1/

The Tulare County, California Farm Advisor, reports that the use of tensiometers is a "must" in solving irrigation problems. Benefits from the use of tensiometers in this area can be measured in part by their widespread acceptance by fruit growers. He estimates that more than 2,500 tensiometers are in use to aid in more intellegent irrigation water use on more than 10,000 acres of Tulare County citrus orchards.

Soil Management in Orchards and Vineyards.

During the early decades of the western fruit growing industry, clean cultivation was a universal soil management practice. Weed growth developed during the growing season after each irrigation. This growth was controlled while still small by cultivation after one or two irrigations. The soil surface was then harrowed, smoothed with a drag and refurrowed for the following irrigation. Maintenance of a surface "dust mulch" was an objective of tillage, smoothing and harrowing with the thought that this prevented the loss of soil moisture by capillary movement from the root zone. It is now known that soil moisture loss is not significant from soil depths of more than the surface few inches except as removed by plant roots.

Annual and natural covercrops came into use when orchardists became concerned with "tillage pan" development due to frequent disking and excessive tillage. Soil organic matter was gradually depleted and soil tilth had deteriorated. Farm manures previously used for orchard fertilization were less readily available and more expensive. Orchardists began to let natural weeds and grasses reach considerable development before disking to increase organic matter in the surface soil. Some seeded cereal grains and annual legume covers are used.

The use of annual or temporary covercrops at different seasons of the year may be adjusted to the available water supply. Clean cultivation or minimum tillage is practiced more generally in summer to reduce competition of the covercrop for soil moisture during this high evapotranspiration period. In

1/ Advances in Soil Physics, by L. A. Richards, 7th International Congress of Soil Science. Madison, Wisconsin, 1960

the Mediterranean-type climate of coastal areas, natural or seeded annual cover is grown during winter and early spring on rainfall moisture. This minimum tillage, temporary-cover type of orchard soil management is generally acceptable where valid objectives are satisfactorily achieved.

With citrus and some other subtropical fruits, a clean-tilled, firm soil surface is advocated in midwinter in some areas to gain a few degrees' temperature advantage for fruit on the trees at that time. This same advantage is sought by some deciduous fruit growers during the fruit blossoming and new shoot development period of early spring. Experimental results indicate an orchard or vineyard with covercrop will experience a few degrees' lower temperature on frosty nights than one with a bare firm soil surface.

<u>Permanent covercrops</u> in orchards serve a number of important objectives:

1. Erosion on strongly sloping orchard sites is largely eliminated.

2. Irrigation water intake rate is improved on finer-textured, or compacted surface soils.

3. The sod and accumulated plant residue provides a protective pad to reduce soil compaction by equipment traffic.

4. Organic matter is gradually increased in the surface soil layer.

5. Fruit plant roots develop closer to the soil surface where soil aeration and plant nutrients may be at optimum levels.

6. Micro-climatic environment in extreme desert areas is favorably modified by covercrops through cooler surface soil temperatures, lower atmospheric temperature, increased relative humidity and reduced reflection of the intense heat and sunlight. 1/

7. Costs of soil management are reduced over customary tillage operations.

8. Soil fertility is improved where legumes are used.

9. Improved fruit color, early maturity and enhanced fruit quality can be obtained through soil nitrogen manipulation by a grass cover.

10. A well-adapted and maintained permanent cover will usually suppress or prevent noxious weed development.

1/ Fruit loss as high as 65% was reported in Tulare County, California vineyards, where the light soil was completely clear of cover growth during an excessively high temperature period in June, 1961. Maximum daily temperatures for June 14-17, averaged 111.5°F. The small grape berries shriveled on the vine. Where a covercrop was used, even of watergrass or other weed growth, the damage was reduced or prevented.

Some minor disadvantages of permanent covercrops in orchards and vineyards may be significant in local areas.

1. The colder temperature effect during periods of slight frost has been mentioned. The increased use of artificial frost protection methods, particularly of wind machines, tends to compensate for this adverse effect.

2. Increase in irrigation water requirements is important in some areas of high water cost and limited supply. One or two extra mowings of the cover from midsummer to early fall will somewhat check cover regrowth and reduce the competitive effect for soil moisture. 1/

3. Some additional fertilizer is generally required in addition to that supplied for the fruit plants. Commercial fertilizer is inexpensive. An increase of 25 to 30% of nitrogen application should suffice for a grass cover. After a few years, the legume in a legume-grass cover should provide the nitrogen requirements for the grass in this mixture. By this time, plant nutrients are being returned to the soil from the decomposed covercrop residue since none of this is removed.

4. Undesirable perennial weeds and grasses may invade a permanent cover. Quackgrass or Kentucky bluegrass may be considered undesirable in some orchard areas. Bermuda grass and Johnson grass in others. Dandelion and Canadian thistle are invaders in some areas. Good water and fertility management of the seeded cover will generally prevent the establishment and increase of noxious invaders. Spot chemical spray applications may be used to eliminate noxious invaders. Breaking out the old cover and reestablishing it with the best adapted species or mixture for the soil and climatic conditions may be required after a period of years.

   In other cases, a perennial grass invader will provide an entirely satisfactory permanent cover. Quackgrass has proved to be in many Wenatchee apple orchards. Bermuda grass may be satisfactory in hot climates, particularly if properly managed or if a turf type is used.

5. Orchardists have long experienced damage by field mice girdling tree trunks in covercropped orchards. Wenatchee apple growers no longer consider this a serious problem. Where a buildup in mouse population is evident, an endrin spray of infested areas results in positive control.

1/ Influence of N Fertilization and Clipping on Grass Roots. Bertrand and Teel, So. Sc. Soc. Am. Proc. 23, 1959

<u>Weed-free, non-tillage</u> in orchards and vineyards is the practice of weed control by use of chemical sprays. Light oils have commonly been used. Among newer herbicides in use are diuron, monuron, simizine and other substituted phenylureas and triazines. Some are applied to the soil to kill germinating seedlings; others to the vegetative growth of grasses and broadleaf weeds. Many have positive qualities of selectivity. Some of these are not cleared by agricultural regulatory agencies for use in all orchard and vineyard areas. Chemical weed control is being increasingly practiced in the southern San Joaquin Valley and southern coastal citrus areas of California.

Use of this practice nearly always results in an increased irrigation water intake rate of soils with a compacted surface layer resulting from previous tillage. There can also be some saving in irrigation water over the use of temporary or permanent covercrops. After an initial period of use, the cost of chemical weed control will generally be less than for tillage. Harvesting, spraying and other operations requiring equipment traffic in the orchard area are faciliated. Some fruit growers place an esthetic value on use of the practice due to the clean appearance of the soil surface.

Chemical weed control is also coming into use to remove weed and covercrop growth from an area immediately around and under fruit trees in the tree rows of covercropped orchards and in the trellised rows of vineyards.

<u>Mulches</u> are used as a soil cover for erosion control in many orchards on strongly sloping sites. They may complement the practice of weed-free, non-tillage and the use of a sprinkler irrigation system. Materials used include straw, low value hay, sawdust or wood shavings, farm and feed-lot manures.

The use of mulches will reduce evaporation from the surface soil, reduce its radiant heat absorption, temperature and noctural heat emission. Somewhat less irrigation water will be required for orchards with a mulch cover than where covercrops are grown. Soil moisture and aeration may be maintained at nearer optimum levels in the surface soil layer under a mulch cover.

<u>Soil Fertility</u>. All western fruit growing enterprises require the use of a systematic, intelligent fertilization program for successful production of commercial crops. A fertilizer program for orchards and vineyards can differ considerably from one designed for field crops. Fruit plants are perennial and can store nutrients in plant tissue from one year to the next. Nutriment requirements can be met over a longer growing period than for most annual crops.

Nitrogen is most universally required by fruit plants. It is inexpensive and readily available to plants after application to the soil. Evidence of phosphate fertilization for fruit crops in western soils is rare. Deciduous fruit plants may require the application of potash on some soils.

Deficiency symptoms of micro-elements including iron, zinc, manganese and even boron are generally quite specific but comparatively rare. Most of these elements are reduced in availability in strongly alkaline soils. Deficiency effects are commonly aggravated with over-irrigation, with fine textured soils and those with a high or perched water table. A deficiency condition may be corrected by adding a salt form of the needed element to the soil, as a foliar spray or even in holes bored in the tree trunk.

Soil analysis, leaf blade, leaf petiole and fruit analysis can be of help in determining fertilizer requirements of fruit plants. Most fruit growers have acquired a working knowledge of "hunger signs" of specific nutrient deficiencies and make applications of corrective materials. State Extension Service representatives may be consulted in stubborn cases. Their recommendations are generally adequate to meet most fertilizer problems of fruit crops.

The manipulation of nitrogen availability to fruit crops grown with a permanent grass covercrop is of increasing interest. The practice is used effectively with apple and cherry production in Washington State, Idaho, Utah and in other western states with different fruit crops. Mineral nitrogen is applied in late fall for all or most of the requirements of both the grass cover and the fruit plants. Sometimes the application is split with a spring application made in a band circling the tree several feet from the trunk and alongside the vine rows of vineyards.

Nitrogen requirements of the fruit plants are thus met to provide for the blossoming and fruit set, for new shoot growth and into midseason to insure adequate fruit spur development and fruit bud differentiation. By midsummer, a continued but diminuating soil nitrogen availability will assure fruit development to satisfactory size at maturity. If nitrogen availability remains high or even relatively abundant into the fruit maturation period, fruit maturity and color can be delayed and quality depreciated. This is where a grass covercrop plays an important role. It is a continuous and heavy user of available nitrogen through the growing season and into the late summer. Wenatchee, Washington apple growers want the supply of soil nitrogen available to the tree severely depressed to near zero as the fruit matures. Many of these growers and some pear growers in the Medford, Oregon area report a higher percentage packout of extra fancy grade fruit after changing from a tillage program to permanent grass cover.

Nitrogen manipulation with a permanent grass cover can also influence the quality of earlier maturing kinds of fruit. Cherry growers in western states have found that too much nitrogen available to the trees as the fruit matures results in the development of a soft fruit difficult to harvest and ship. Many have adopted a permanent covercrop program.

Field observations were made of soil and water conservation problems and conservation practices of some orchard and vineyard areas in six western states during 1961 and 1962. Some high points of these taken from reports to state conservationists are presented.

Washington State

Orchard conditions and practices of the Yakima and Wenatchee apple areas were made in connection with an inter-area orchard covercrop workshop in August, 1961.

Washington State's apple industry dates into the past century with some orchards now 60 and more years of age. It is famous for the Red Delicious variety shipped extensively throughout the United States. Extensive orchard replacement has taken place in the last decade due, in part, to the market superiority of new "super-red" strains of Delicious and Rome varieties. Replacement has been by complete orchard removal and replanting as well as by inter-planting and top-grafting.

Orchards are located on benches above narrow to somewhat broad river valleys (the Yakima and Columbia Rivers) and on adjoining rather undulating and sloping foothill sites. These topographical features insure good air drainage and relatively frost-free conditions during the fruit blossoming period.

Soils of these fruit areas vary widely from deep to fairly shallow, medium to light in texture with moderately slow to moderately rapid infiltration rates. The available moisture capacity of a typical orchard soil ranges from 1.5 to 2.2 inches per foot.

Some characteristic soils on which orchards were examined with their more pertinent mapping symbols are:

Cashmere sandy loam	1M34	Selah loam	4M3R
Ritzville silt loam	1M3, 4M3	Malaga fine sandy loam	3cL5
Wenatchee silt loam	2M26	Harwood loam	3M4R, 2M4R
Tieton loam	2M4B, 3M4B		

Irrigation water of excellent quality is supplied these orchard areas at a cost approximating $10.00 per acre per year. The average seasonal depth of water use is about 35 acre inches applied in from 8 to 12 irrigations. There is some evidence of excessive application of irrigation water, although adverse effects are not apparent because of the more open, well-drained soils.

While most of the orchards were formerly rill-irrigated, the sprinkler system is now increasingly used. This system has permitted the reduction or elimination of soil erosion on the sloping orchard sites, a better application of

water for the permanent covercrop system now more commonly used and a more uniform water application to all trees in an orchard. It is also stated by most orchardists that a saving in the cost of irrigation labor is effected and the amount of water used is reduced.

Dr. C. H. Zeroske, Agricultural Economist of Washington State University, has reported on a survey of irrigation system use in Washington apple growing areas. He found that sprinkler irrigation has increased markedly relative to rill irrigations in the past seven years. In 1953, 25% of the orchards were sprinkler irrigated while by 1960, 43% were using the sprinkler system.

A larger percentage of the sprinkler irrigation systems is found in the Wenatchee area with about two-thirds of all orchards using sprinklers as contrasted to one-third of the Yakima orchards using this system. The study intimates that the hours required to irrigate an orchard have remained about the same through this period of years, but that the changeover may have resulted in the improved use of irrigation water.

The irrigation interval for bearing orchards in midsummer varies from 6 to 9 days on the coarse, shallow soil underlain by open cobble of some orchards near East Wenatchee, to an interval of from 14 to 24 days on the deeper loam and sandy loam soils. An orchardist near Selah irrigates his young orchard in permanent cover by wetting alternate middles each 14 days; while another with a 60-year old orchard on a deep Cashmere sandy loam in permanent quackgrass and bluegrass cover west of Wenatchee is irrigated at 24-day intervals.

A permanent covercrop is maintained in a large percentage of the orchards in these areas. This change from the traditional clean cultivation system has been gradual until recent years when the relationship between a permanent grass covercrop and fruit quality became increasingly apparent. Dr. Benson of the Washington State Tree Fruit Experiment Station at Wenatchee has reported on nitrogen manipulation with the use of grass covercrops and the effects on fruit quality. He has cautioned, however, against the use of too little nitrogen which would result in reduced fruit size and yield.

Grass covercrops are established in many orchards by seeding. Several Fescue grasses, Kentucky bluegrass and orchardgrass are commonly used. Some orchardists use half Ladino clover and half Fescue with the expectation that the grass would later dominate the cover. Actually, when orchardists change from rill irrigation to sprinklers, many quit cultivating. Natural cover, chiefly quackgrass and Kentucky bluegrass, take over. Quackgrass is a vigorous growing, spreading weed grass of these orchard areas and will invade and may become dominant in most natural and seeded cover. Under the practice of clean cultivation, it was a principal weed which orchardists attempted to control by frequent tillage. Yet, it always came back with vigorous growth.

The experience of Chet Frazier, Manager of the Dr. Hutchinson orchard, and a Supervisor of the Wenatchee-Entait SCD, has been rather widely recounted by John Moats, WUC at Wenatchee. After several years of trying to control or eliminate quackgrass in this orchard, Mr. Frazier quit cultivating and decided to let the grass take over as a permanent cover. He has found it to be quite a satisfactory cover requiring no different management than that of any other grass used in the area. It has improved the soil in structure, tilth and water intake. Yield and quality of fruit in this orchard are now excellent. A cost-return analysis of this change in soil management will show a significant saving by the elimination of all tillage costs and greater returns from the fruit crop through a higher percentage pack-out of Extra Fancy grade fruit.

Covercrop growth in orchards of these areas is controlled at intervals through the growing season by use of a rotary-mower or roto-beater. Most orchardists mow the covercrop three to four times during the summer, including once in the tree middles after the limb props are placed to facilitate fruit harvest operations. They may also mow the cover quite closely after harvest and use a tree-hoe or chemical spray around each tree as a deterrent to field mouse population build up in winter.

Some SCDs own roto-mowers available to District cooperators at a rental rate of $1.75 per hour. The orchardists use their own light tractors with these mowers. The custom rate for orchard covercrop roto-mowing is $6.00 per hour.

Idaho

Some time was spent with an orchard land use technical guide committee and with several orchardists in the Gem and Payette SCDs. Essential and supporting conservation treatment measures were considered and tabulated by land capability units for the soil series and phases associated with orchard land use in these Districts. Specifications were prepared for these measures.

These are successful orchard areas. In many cases, tree fruits are the only crops produced by a land owner. Orchardists are well-informed on most soil, water and plant management practices. Yet, the most critical conservation practices are not applied as widely as is desirable. Many orchardists are in need of assistance with covercrop establishment and management, with irrigation system improvement and with improved irrigation water management.

It is likely that most orchardists in these Districts over-irrigate, at least during a part of the growing season. There is a need for a better understanding for timing of irrigations to replace water use by the trees and covercrop at different periods during the growing season. While irrigation water is abundant and cheap, the cost of irrigating can be a significant production factor on a cost-return basis.

The committee's consideration of irrigation water management disclosed the fact that orchard irrigation guides have not been developed for these orchard areas. Information developed for such guides would be helpful to soil conservationists working with orchardists in assisting them with a more intelligent irrigation program. It was also considered desirable to consider the use of tensiometers to aid the orchardist in determining the rate of soil moisture withdrawal by fruit trees at different soil depths, and to determine the timing and amount of irrigation water application.

The use of permanent covercrops is increasing in these Districts. More sprinkler irrigation systems are being installed. Both are considered essential practices on the steeper orchard sites. The practices complement each other and are commonly applied at the same time. Orchardists have found it quite difficult to establish a covercrop on steep sites with a coarse textured soil with furrow irrigation. The erosion hazard increases the urgency for changing from furrow to sprinkler irrigation.

These practices with some supporting measures could well receive further detailed study through a scheduled orchard conservation practice workshop similar to some which have been held in other western states. This need involve but a small number of field personnel and a period of 3-4 days should suffice. Mr. Austin, Washington-Field Agronomist, has assisted with this type of activity in some other states and could, no doubt, help organize and conduct such an endeavor.

Utah

Field examinations were made at various locations along the Wasatch Front in Utah from Payson on the south to near Tremonton on the north. Most of the orchards are located on slightly to strongly sloping sites at the base of the Wasatch range of mountains but above the lowlands adjacent to Utah and Great Salt Lake. Good to excellent air drainage prevails on most sites due to the sloping terrain and to the vast expanse of lowland and water area below for disposal of colder air on frosty nights during the tree blossoming period. Slopes range from 1-3% to as much as 18%.

The irrigation water supply of this agricultural area is generally adequate but may be in short supply during the latter half of the growing season in drouth years. The 1961 season was one of short water supply. Orchardists knew in advance they could expect a reduced delivery or possibly no water after midsummer. Many orchardists modified their irrigation program somewhat to bring water application into closer relation to the trees actual requirements. The soil moisture regimen maintained was doubtless well within the range of adequacy. A number expressed surprise and satisfaction that neither trees or the covercrop used in some orchards showed particular water stress and normal fruit crops were harvested. This supports somewhat the likelihood that even in areas of traditionally limited water supply, over irrigation may be commonly practiced.

Soils of this agricultural area are of medium to light texture, moderately deep to deep, with adequate to excessive internal drainage. They range in capability unit from IIe1 to IVe3s4. The average available moisture holding capacity per foot of root zone ranges from 2.0 inches for the Davis loam, Ironton silt loam, Parleys and Pleasant View loams to 1.5-1.0 inch for the Cleverly fine sandy loam and the gravelly loam soils over very rapidly permeable gravel substratum. The soils near both extremes of the textural range are considered problem orchard soils; on the one hand, those with slowly permeable subsoil and substratum, on the other, soils with very rapidly permeable subsoils. Improved irrigation water application and proper irrigation water use are basic conservation practices for all orchard enterprises and are critically essential for the problem soil conditions mentioned.

The furrow system of irrigation is the traditional method used in the orchards of this area. There is considerable evidence of erosion in furrows on slopes 5 to 8% and above where the soil is clean cultivated. Practices used to check or eliminate erosion are the use of a permanent covercrop and the installation of a sprinkler irrigation system.

Some orchards are laid out for irrigation on the diagonal to reduce the irrigation furrow gradient to 5% or less. This is a satisfactory plan where the irrigation run does not exceed 600 feet on deep, medium textured soils or 100 to 200 feet for gravelly or sandy loam soils over a very rapidly permeable substratum.

One orchard was observed on contour benches across a 15 to 18% slope. Site preparation was extremely costly but would permit of efficient water application if adequate control is exercised at all points. A new orchard development on this type of site today would likely use a sprinkler system and a permanent covercrop with very little or no site preparation required.

Concrete lined ditches had been installed for surface irrigation of another orchard across an 8 to 10% slope at an estimated cost of about $65 per acre. This practice is most effective in surface irrigation water control. Our reaction, however, is that the operator could well have considered the alternative installation of a sprinkler system to secure several additional advantages at an estimated additional cost of $35 or less per acre.

An irrigation water users group has just completed a pressure water distribution system in the Layton area from a diversion in Willard Canyon. Its use will make possible the delivery of irrigation water to each farm and orchard under sufficient pressure to operate a sprinkler system. With several sprinkler systems already established in orchards of this area, it is anticipated that many other orchardists will change from surface to sprinkler irrigation.

It was indicated that the use of permanent covercrops as a soil management and erosion control practice is increasing in this fruit growing area. The reduction or elimination of soil erosion is the principal objective. In

addition, a covercrop adds organic matter, improves or aids in the control of water intake, and avoids the destruction of surface feeding tree roots by tillage. Management of the cover by roto-mowing is much less costly than tillage operations. The permanent cover does require some additional fertility and water; possibly a fifth more water and a third to a fourth more nitrogen. A legume in a grass legume mixture can, after a few years, supply the additional nitrogen requirements. The proper use of irrigation water with or without the installation of a sprinkler system can in many cases effect a water saving to largely provide the additional water requirements of the covercrop. Again, one or two extra mowing of the covercrop after midsummer will check the covercrop's use of water at a time when water use by the trees is at a peak rate.

The orchard area of the Payson Work Unit was studied. This is an old well-known orchard area with considerable expansion taking place in the West Mountain area. Soil and water conservation practices were discussed with Reed Wayman at his orchard in this area. He is one of the most progressive operators contacted. As an example, most of his orchard area is covered by sprinkler irrigation system; he uses a permanent covercrop and has a complete understanding of the effect of nitrogen manipulation by this cover on fruit quality and the development of high fruit color. Mr. Wayman practices frost protection through the combined use of orchard heaters and wind machines. These are the first wind machines known to be put into use in Utah.

Many other orchards in this area are in permanent grass covercrop and are sprinkler irrigated. Orchard plantings will likely expand in this area since site conditions are favorable and encroachment by non-agricultural developments is not imminent.

The Horticultural Field Experiment Station of Utah State University was visited. A good example of contour orchard layout is found on this station. The contour irrigation furrow gradient is about 3%. It was proposed that the Experiment Station consider installing a sprinkler irrigation system and use a permanent covercrop on at least one experimental block.

Many orchards observed in this agricultural area are in need of conservation practices and treatment measures, particularly of those discussed. Several deterrents to the adoption of an orchard conservation program are recognized. Orchard units are of small acreage. Many are rather incidental to a general field crop enterprise. Many others are maintained in connection with a rural homesite with the owner fully employed in industry or in one of the near-by cities. Still others are in the path of inexorable urban expansion and are in a state of semi-abandonment. Then again, the time of work unit technicians is more than fully used to meet the conservation planning demands of full scale farm enterprises including a heavy ranch planning work load in some Districts. Yet there are good examples of fully effective and intelligently managed orchard conservation programs on the ground. Opportunity exists for much more orchard conservation effort. Real progress is assured in proportion to conservation planning time available and used for orchard conservation planning activities.

California

Citrus fruits and avocados are quite exacting in their climatic requirements. They are classed as subtropicals even though indigenous to the tropics. Most of the commercial citrus and avocados of the world are produced in subtropical and semi-tropical areas bordering the temperate zone where they approach the extreme limit of their climatic adaptation. Neither of these fruits can withstand more than a few degrees of frost. It is true that species of citrus and races of avocado vary somewhat in frost tolerance. The orange and grapefruit are more frost resistant than is the lemon or lime. The Mexican race of avocado is somewhat hardier than is the Guatemalan or West Indian.

The orange is the principal citrus fruit grown in the Riverside, Corona and Redlands citrus area. Many of the orange groves are 50-75 years of age. Winter temperatures of the Santa Ana Valley side slopes and adjacent low benches and terraces are generally favorable for citrus fruit production. Yet, orchard heating is widely practiced. In more recent years, wind machines are increasing in use for frost protection.

Irrigation water management is one of the most exacting operations in the production of citrus fruits in this area. Surface irrigation is the system most widely used. Compaction of the surface soil layers by tillage has modified the water intake rate in many older orchards. Some have areas of deteriorated tree condition due to inadequate or ununiform irrigation water application. Changes in the soil management program and improved water application will tend to correct these adverse conditions.

The sprinkler irrigation system is being installed with most new and replacement citrus plantings as well as in some old orchards. It is strongly recommended for C slopes and steeper sites and for those with undulating topography where heavy land leveling expenditures are required for surface irrigation.

Work Unit Conservationist Epstein of the Redlands Work Unit, considers the proper application of irrigation water the most critical citrus orchard problem in his work unit. His study of the disposition of applied irrigation water in the root zone of orchard trees and of water use by citrus trees throughout the year has enabled him to associate soil moisture conditions with the general health and fruitfulness of the trees.

Tillage and soil management practices vary widely in orchards of this citrus area. Weed-free non-tillage is practiced in about half of the older orange plantings of the Riverside Work Unit and is increasing in use. It is also extensively used in the citrus orchards of the Redlands Work Unit. This practice appears to have some distinct advantages. Soils which have acquired a compacted surface soil layer through long years of tillage develop an increased water intake rate following cessation of tillage for weed and

cover control. Earl Shade, Riverside Work Unit Conservationist, reports this to be the experience of many orchardists after adoption of the practice. This effect is also reported from research by the California Agricultural Experiment Station.

A question may be raised regarding soil organic matter maintenance with a weed-free non-tillage system. Some growers use surface mulch materials of feed lot manure, straw or alfalfa hay, especially with sprinkler irrigation and on steeper sites. Shade pointed to the presence of a significant surface accumulation of fallen leaves and shredded tree prunings under old orange trees. Active tree roots were found within 2-3 inches of the soil surface. These roots are not severed or disturbed by tillage with sprinkler irrigation and only at considerable intervals when furrows are reshaped for surface irrigation.

Winter Cover Crop - Summer tillage is a widely practiced soil management program in citrus orchards of these work units. The covercrop, if seeded, is established with minimum seed-bed preparation in September. Naturally-seeding winter weeds of mustard, mallow and some winter annual grasses commonly make a good growth after the fall irrigation and with the normal winter rainfall. Excellent erosion control is provided against storm run-off on the more steeply sloping sites. The winter growth is disked in the spring. Cover control by minimum tillage in summer may be considered as a compromise between the heavy expense of clean cultivation with resultant soil compaction and some increase in the cost of extra irrigation water required by the covercrop.

Several thousand acres of young orange plantings in the Lake Mathews citrus area of the Riverside Work Unit, were observed. Much of this land was formerly in dryland wheat production. The rolling and hilly terrain provides generally favorable winter temperatures. Water from the Colorado River Acqueduct is metered at delivery point to each unit at a cost of about $35 per acre foot. Earlier plantings were made on contour gradient bench terraces and furrow irrigated around the rolling to strongly sloping hills. Land preparation was quite expensive. Extensive additional plantings are being made in this area. With most of these, the drag-hose sprinkler system is installed without land surface modification. This alternative plan appears more acceptable to the heavy terracing used for the earlier plantings. It involves little or no additional cost.

Avocado orchards of the Escondido and Fallbrook area occupy essentially frost-free sites on sloping to moderately steep foothills. Assuming an adequate supply of good quality irrigation water, the most restrictive requirements for successful avocado production are a frost-free site and a medium-to-light textured, well-drained soil. Conservation practices to effect erosion control are most universally required.

Work Unit Conservationist John Miner's report on the correlation of soils series and the incidence of the avocado or cinnamon root rot in the Fallbrook area is of interest. The development of this root rot fungus is favored by

the retention of excess soil moisture in the root zone. Miner found the highest root rot losses occurring on the Mirriam series of shallow depth underlain by a compact claypan. Somewhat lower root rot incidence occurred on soils of the Fallbrook series. The least root rot loss is experienced on the Vista soils series which have adequate internal drainage.

New avocado plantings are now being made without land shaping or terracing. The natural brush cover is disked, the sprinkler irrigation system installed and a covercrop planted in the fall to provide erosion protection during the winter. A permanent covercrop or a mulch cover are alternative minimum conservation treatment measures. Naturally reseeding winter cover is sometimes used and growth is controlled as required by mowing. Weed-free non-tillage is not commonly practiced in avocado orchards.

Proper irrigation water use is a most critical, essential conservation treatment measure with avocados. An exacting irrigation schedule is most imperative on soils with the more slowly permeable subsoils. Avocado orchards on soils with poor internal drainage are experiencing salt injury with the use of Colorado River water. Some excess of this irrigation water must drain from or through the root zone if harmful salt accumulations are to be avoided. The installation of drainage systems is about the only conservation treatment measure that will remedy this situation since Colorado River water carries about one ton of soluble salts per acre foot of water.

Fruit crops grown in the Coachella Valley are principally grapefruit, dates and early maturing varieties of the Vinifera grape. Irrigation water is now supplied from the Colorado River through the Coachella branch of the All-American Canal. The date palm is ideally adapted to the extremely hot, arid climate of the Valley. The Vinifera grape and grapefruit are somewhat less well adapted but crops of these are early maturing and of excellent quality. Some grapefruit are grown as inter-plants in the more mature date orchards where the partial shade somewhat modifies atmospheric aridity and temperature to provide more favorable micro-climatic conditions.

Indio and Coachella soil series of the valley are coarse to medium in texture with moderately rapid to rapid permeability. Heavy annual irrigation water use is dictated by the high evapotranspiration rate and permitted by the generally abundant supply of low cost irrigation water.

Soil management practices include a costly tillage program to control the naturally heavy growth of Bermuda grass and other weedy plants. Alternative grass control or suppression practices may have a place in both date and grapefruit plantings in the valley. One such method is chemical, weed-free non-tillage. A combination of chemical grass control and a mowed grass strip was observed in one orchard. No tillage was used. Chemical spraying maintained a bare tree row strip equal to the spread of the trees in width. A mowed, permanent Bermuda grass cover was maintained between the tree rows. The grass and the bare strips were approximately of equal width in this grove.

Bermuda grass control in the more limited spacing of vineyards is a continuing and costly practice. The question is raised of the technical feasibility of maintaining a mowed grass cover in vineyards, or possibly using a combination of chemical control and roto-mowing. Field trials to make such determinations and an analysis of the costs involved should be of interest.

Several thousand acres of new citrus orchards have been established in the Fresno and Visalia Work Units of the San Joaquin Valley. Much further expansion is underway and planned. These are located on the east side of the Valley on generally sloping to hummocky or undulating terraced sites near the foothills. Much of this acreage of both older and of new citrus orchards is situated on soils of the San Joaquin series broadly described as "well-drained, non-saline, non-alkali, dominantly medium textured with iron-silica cemented hardpans." They are shallow, at best, with a restricted root zone. Internal drainage is commonly poor to negligible. They are mapped as capability unit IIIs3.

Except with the use of an extremely careful irrigation program, a perched water table develops in the root zone of these soils. A serious reduction in soil aeration impairs citrus root health and growth. In some locations, free water enters the soil of an orchard from higher irrigated areas moving on the cemented subsoil stratum. Some of the older orchards in a drainage project on this soil had areas of advanced tree deterioration characterized by small, sparse foliage with very little fruit being produced. Numerous tree replacements were in evidence.

Blasting tree holds into or through the cemented hardpan of these soils has been extensively practiced in preparing this type of land for orchard use. More recently, the Navelencia SCD has operated a "big-tooth" ripper to break through the cemented subsoil for the tree rows in both directions and, in some cases, at 36-60 inch spacing. The effective ripped depth is from 4-4½ feet. A somewhat expanded root area of soil has been developed by this treatment.

Both surface and sprinkler irrigation systems are used in this citrus area. Installation of the drag-hose sprinkler system appears to be increasing. With this system the sprinkler heads discharge at ground level under low pressure. An intelligent irrigator using this system should be able to carefully control the depth of each water application by adjusting the time the sprinklers operate. Should the need become apparent, a reduced application can be given to a small area of trees by closing the valve of an individual hose, or to an individual tree by shutting off a single sprinkler head.

Limited use of summer covercrops of annual grasses and weeds is common in the area in connection with minimum to frequent tillage. It is suggested that a summer covercrop with sprinkler irrigation should provide a more favorable micro-climate in a citrus orchard during the critical "June-drop" period of fruit development. With ample available soil moisture in the root zone during such periods, the alleviatory influence is due to a higher

atmospheric humidity within the orchard area. An orchardist in Success Valley is reported to have installed an overhead sprinkler system to cool the orange trees and reduce excessive fruit drop during high temperature periods in June. Many orchardists completely reduce all cover growth in late fall and maintain a bare soil through December and January. Others are changing to a weed-free non-tillage program.

Vineyardists of this part of the San Joaquin Valley commonly use a summer tillage system of soil management for complete or partial control of weed and grass cover. Covercrop and tillage practices used in an Emperor grape vineyard in the Ivanhoe area near Visalia were observed. The soil in this vineyard is characteristic of the San Joaquin series. A natural summer covercrop of annual grasses is maintained from May until after fruit harvest in late October. Growth of the cover is controlled as required by roto-mowing. Three or four mowings are substituted for an equal number of diskings. Natural winter annuals develop to provide winter cover. This is disked in late winter after roto-beating the vine prunings. The summer covercrop is then permitted to take over. An effect of the summer covercrop program was the development of a higher colored, sweeter and firmer fruit.

A cost analysis of this and other combinations of minimum tillage and semi-permanent cover management in vineyards is recommended as information is developed for Section V of the Technical Guides in these work units. The technical feasibility of such a program should also be made, of a wider use of minimum tillage with a managed covercrop in Thompson Seedless vine-yards where the fruit is dried on trays between the rows of trellised vines in late summer.

Arizona

Yuma County, Arizona has a citrus development of nearly 16,000 acres, most of it located on the Yuma Mesa. The majority of this acreage is of non-producing age. About 8,000 acres are planted to Valencia oranges; 6,000 acres to lemons and 2,000 acres to grapefruit. Most of the new plantings are oranges. Acreage is expected to expand rapidly on the remaining 4,000 acres of the Yuma Mesa Irrigation District and on the nearby Wellton Mesa, where some 700 acres have now been planted.

The Yuma Mesa is a relatively level area lying some 75-80 feet above the Yuma and lower Gila valleys. The climate is characteristic of the extreme hot, arid desert with mild winter temperatures with but occasional frosty nights expected. Some frost damage to fruit and tree foliage was experienced in January 1962 and light frost can be expected a few nights most years. The young trees are wrapped for frost protection and wind machines are commonly installed when the trees begin fruit production, one for each 10 acres.

The soil of the Yuma Mesa is classed as Superstition loamy sand. It is Capability Class IV of unlimited depth with a water intake rate of as much

as 10 inches per hour. Irrigation water is applied in heads up to 15 cfs to practically level borders two or more tree row spacings in width by 600 feet in length. The minimum depth of water which can be applied each irrigation is from 4 to 6 acre inches.

Citrus fruits grown on the Yuma Mesa are subjected to extreme conditions of high summer temperature, low aridity and intense sunlight. Yet, man can introduce management practices which may somewhat alleviate these climatic extremes. Surface soil temperatures are reduced by frequent irrigations throughout the summer. A permanent covercrop or a cover maintained through the full summer period will reduce the extreme reflection of sunlight and heat from the light-colored soil, will further cool the surface soil layer and will provide a somewhat modified micro-climatic effect in and about the trees by lowering atmospheric temperatures and increasing humidity. This modification can be especially advantageous during the blossoming and fruit setting period from April to July. Otherwise, June fruit drop may be excessive and the fruit set can be greatly reduced below the trees' productive capacity.

Sprinkler irrigation is not practiced in the Yuma County citrus areas, although the Arizona Agricultural Experiment Station has an experimental installation for a study of this irrigation method. The use of sprinkler systems could reduce peak water delivery requirements of the project and greatly reduce the annual water use.

All orchard plantings appear to be receiving adequate fertilizer with nitrogen the most common element applied. With younger plantings, split applications are used at about monthly intervals during the growing season. This tends to reduce loss of soluble nutrients by leaching. A considerable acreage now planted to citrus on the Yuma Mesa had been in alfalfa three or more years before tree planting. One operator indicated that he preconditions the Yuma Mesa soil with three years of alfalfa before establishing his orchard. Feed-pen manure is used by some operators to assist in the establishment and development of the soil improvement crop.

Permanent orchard covercrops are not used in this area, although minimum tillage with some roto-mowing of grass and weed growth is substituted for the more commonly used tillage with rotovator and disk. A grass sandburr has invaded this orchard area and constitutes a nuisance-type cover. One operator in the Wellton area is using alfalfa as an inter-crop and soil cover for wind and irrigation water erosion control and for soil fertility improvement.

A field planting trial of a turf Bermuda grass as a permanent covercrop was recommended. It could be maintained at minimum cost by roto-mowing and would not become a noxious cover about the trees since it could not thrive or likely survive in the dense shade. A reseeding annual legume could be used with this Bermuda for a part of the year. The complete reduction of such a cover to provide a bare, firm soil surface for more favorable winter temperatures does not appear justified in citrus orchards on the Yuma Mesa. If

the cover were closely clipped in November, it would permit about as favorable a heat absorbing surface as would the bare, light-colored sand. Wind machines used for winter frost protection should be fully effective with a closely clipped and partially dormant winter cover.

Sustained high fruit yields of citrus orchards on the Yuma Mesa are directly associated with the maintenance of the trees foliage in unimpaired condition throughout the year. These results can be maximized through intelligent application of micro-climatic modifications suggested.

Oregon

The Medford, Oregon orchard area has been well known for its pear production for the past half century. The oldest orchards are now being replaced with new plantings. The climate is that of the milder temperate zone characterized by mild wet winters and generally hot dry summers. Some frost damage may occur during the tree blossoming period, particularly on the more level valley floor. Orchard heating is practiced and extensive crop loss is uncommon.

Soils of this orchard area vary widely. Those of the valley floor are fine textured clay and clay loams referred to locally as "gummy", those of the side slopes are of medium to light texture. The gummy soil puddles and seals over easily from traffic and tillage when wet. Oil tank truck traffic during the orchard heating period and spraying equipment traffic generally occur while the soil is still quite wet from late spring rains. Spring disking to subjugate the heavy, natural covercrop aggravates soil structure deterioration. Attempts to form furrows for irrigation result in a "slick-seal" furrow surface. Water intake rate from such furrows must be practically nil; at best extremely slow. It is likely that irrigation water is applied when the soil is already at or near the field holding capacity. Aeration in the root zone can be severely limited. Poor root health due to the conditions described is doubtless the cause of some of the deteriorated tree conditions observed.

Tillage for grass and weed control is practiced in most of the orchards. Heavy natural cover of rye grass, mustard and other weeds develops in late winter and early spring. The disk is commonly used to cut this growth into the soil. Repeated diskings are required. Yet if it were retained as a semi-permanent cover and managed by mowing, much benefit would result.

Field trials of some perennial covercrops well adapted to the climatic and soil conditions is recommended. Suggested for trial are dwarf orchard grass on the medium textured soils and Alta Fescue on the clay soils. A field trial planting of Lana vetch and perennial rye grass to be managed as a reseeding annual covercrop is also suggested.

A conversion from furrow to sprinkler irrigation can be recommended in connection with the adoption of orchard covercrops. Some few have been installed in old orchards and in younger orchards on the steeper slopes of the valley periphery. Their use could reduce over irrigation rather prevalent in this orchard area. One orchardist who had installed tile drains and a sprinkler system reported improved tree condition, better fruit quality and reduced irrigation labor costs.

Proper use of irrigation water is a conservation measure needed in many of the pear orchards of this area. Orchardists need to follow the rate of soil moisture depletion in the tree root zone and apply water at the intervals and to depths to replenish the soil moisture used. The critical soil depth to observe soil moisture depletion is the 12 to 24 inch zone, particularly when a covercrop is in vigorous growth. As a general rule applications heavy enough to penetrate to lower soil depths will not be required until well into the summer period. Even then, only every second or third application would need to be sufficiently heavy to penetrate below three feet.

With permanent covercrops, orchardists will need to judge quite carefully the fertilizer requirements to meet the needs of the cover, the trees and the developing fruit crop. They will soon gain experience from using average amounts, principally nitrogen, and vary from this amount as the tree condition and fruit size and quality may require.

Some Cost-Return Considerations

The development of cost-return data for conservation treatment measures in orchards and vineyards is in progress in the western states. Crop budgets of fruit growing enterprises were reviewed in several states. Assistance was given in the development of others. Savings in operating costs and benefits in yields and in crop quality enhancement were recognized as treatment measures were reviewed with soil conservationists. A brief reference is made to some of these considerations.

A Washington State orchard covercrop workshop group reported on annual saving of $16 per acre in equipment operation and fertilizer costs for covercropped orchards as compared to those clean cultivated. An apple growers association horticulturist at Pateros, Washington, estimated this saving at $40 annually. Fruit quality enhancement from the use of a permanent grass covercrop was estimated by the workshop group to be in excess of $50 per acre per year.

An increase in the apple crop from 750 to 1,000 boxes per acre in the Hi-Land SWCD at Yakima, Washington, was attributed to the adoption of a combination of needed conservation measures. This increased the estimated net return to the orchard enterprise from about $90 to $340 per acre.

Work Unit Conservationist Earl Shade, studied irrigation water use in citrus orchards near Riverside, California, before and after a change from surface to sprinkler irrigation. Twenty-five percent less water was required with sprinklers, effecting a saving of from $8 to $10 per acre in the cost of water.

A study of citrus fruit production costs on the Yuma Mesa, Arizona, revealed that roto-mowing a covercrop would cost less than one-third that of roto-tilling for clean cultivation for each time over.

A grape grower in the San Joaquin Valley, California, reported he could roto-mow his grass covercrop three times for the cost of one disking.

A comparative study of surface and sprinkler irrigation on the Yuma Mesa was not possible. The combined annual cost of water and labor of application for a young orchard was estimated at $45 per acre. A reduction of one-third this cost should be effected with the use of sprinkler irrigation.

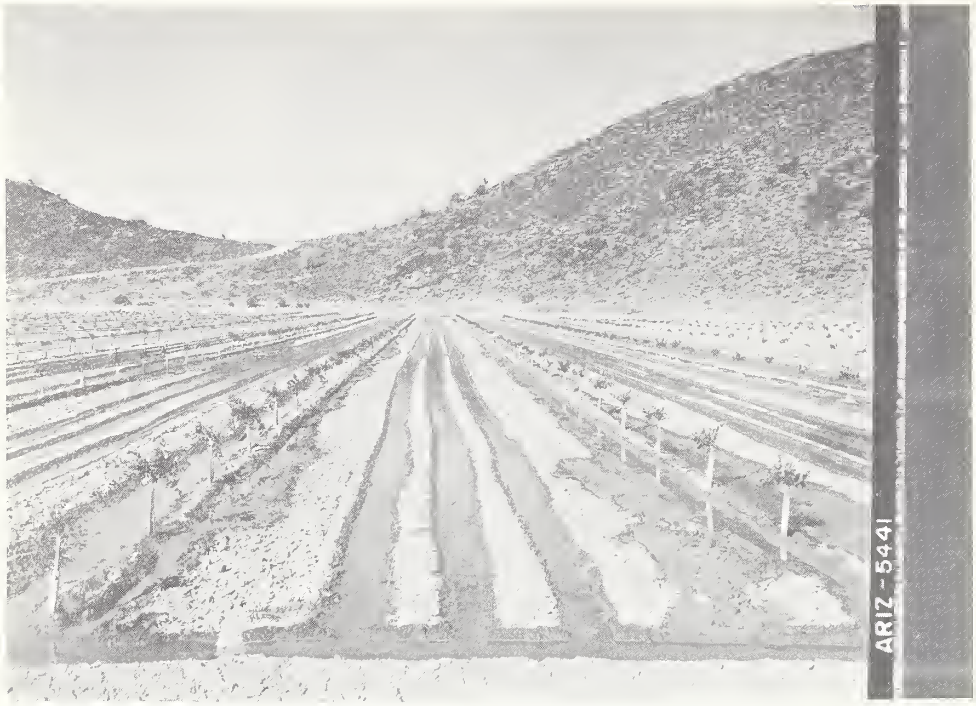
The annual cost of weed-free non-tillage in orchards will range downward from about $35 per acre when the practice is first started to $10 or less per acre after it has been used a few years. In addition to the benefits of improved texture and water intake rate of the surface soil, a cost comparison of this practice with tillage, with the management of a covercrop, and of some differences in irrigation water use can be estimated from local costs of these items.

Recommendations were made to work unit conservationist in a number of orchard and vineyard areas for securing cost-return data for conservation treatment measures. These data will be secured from fruit growers experience and included in Section V of the Work Unit Technical Guides. Cost items involved and the nature of the benefits to be evaluated were fully explored.

The use of cost-return information in assisting fruit growers with conservation planning was also reviewed with soil conservationists. Most recognize the value of these data to a fruit grower with his planning decisions on alternative conservation practices and treatment measures for the betterment of his enterprise operations.

Aerial view of contour terraced orange orchards, Lake Matthews area. Riverside County, California. C-3087-1.

Contour planted vineyard. Sonoma Valley SCD, California. C-3267-12.



Young orange orchard with lettuce seeded between tree rows.
New River SCD, Arizona. F-233-1.

Corn planted for protection (wind & frost) of young citrus trees.
Coachella Valley SCD, Riverside County, California. C-2771-12.

Sprinkler system of plastic & steel pipe being installed before planting orchard. Riverside-Corona SCD, California. C-2124-1.

Sprinkler irrigating in a cherry orchard with Hard Fescue grass covercrop. Gem SCD, Idaho. I-1426-12.

Irrigating a citrus orchard in 42 inch broad furrows. San Fernando, California. C-792-5.

Apricot orchard with irrigation in contour borders. Bolado SCD, California. C-2298-3.

Check system of orchard irrigation. Evergreen SCD, California.
C-6752.

Furrow irrigation lemon orchard from concrete-lined ditch.
New River SCD, Arizona. Ariz-5442.

Sprinkler irrigating young cherry orchard with bulbous bluegrass-vetch covercrop. North Wasco SCD, Oregon. 0-1226-10.

Sudangrass covercrop used between young citrus rows.
Coachella Valley SCD, California. C-1314-3.

Strip covercrop on young orchard. East Wenatchee SCD, Washington. W-2385-6.

Permanent covercrop of a Hard Fescue & Ladino clover. Note the clean cultivation around trees for mouse control. E Wenatchee SCD, Wash. W-1907-7.

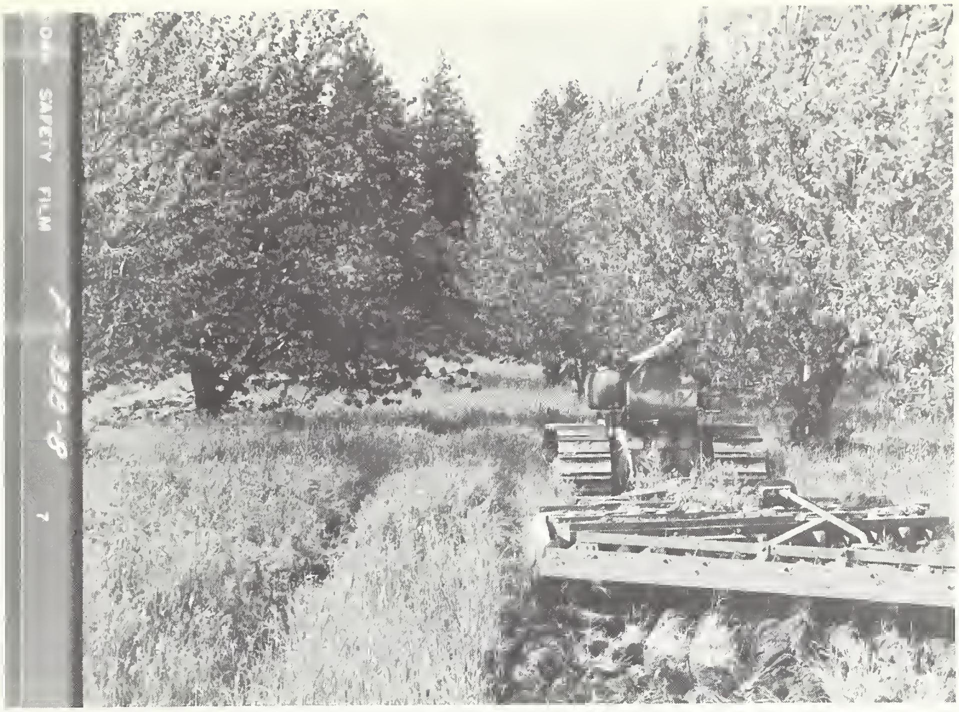
Control of grass covercrop with chemical spray around trees in orchard. Selah, Washington. W-2098-9.

Straw mulch in lemon orchard. San Diego County, California.
C-1738-3.

Erosion control with wood waste mulch in a vineyard.
Willits SCD, California. C-2084-5.

Shredded prunings used as a mulch with weed-free non-tillage in Apricot orchard. San Jacinto Basin SCD, California. C-1214-8.

Furrow irrigation of old orange orchard with weed-free, non-tillage. Riverside County, California. C-796-1.



Disking down annual covercrop of vetch and rye in cherry orchard. Northern Wasco SCD, Oregon. F-338-8.

Disked barley and vetch covercrop in walnut orchard. West Lake SCD, California. C-3211-4.

Strip of alfalfa covercrop in vineyard. Kennewick, Washington.
RO-337-8.

Six year old orchard on Class IV land with an orchardgrass and alfalfa covercrop. Payette SCD, Idaho. I-1569-6.

Apple orchard with covercrop of alfalfa and orchardgrass. Kane County SCD, Utah. U-401-6.

Covercrop of Hard Fescue in eight year old apple orchard. Deep sandy loam soil. Okanogan SCD, Washington. W-1572-7.

Using rotary mower on covercrop in a cherry orchard. Davis SCD, Utah. U-579-7.

Quack grass covercrop in old apple orchard. Loomis SCD, Washington. W-2519-3.

Red Creeping Fescue grass covercrop in vineyard. Lower Yakima SCD, Washington. Wn-90141.